Claims

I claim:

1. An emitter controlled thyristor device having a cathode terminal and an anode terminal, comprising:

a thyristor device having a thyristor emitter, a thyristor collector, and a thyristor gate, said thyristor comprising alternating P-type and N-type semiconductor regions;

a first metal oxide semiconductor transistor (MOS) connected in series with said thyristor between said cathode terminal said thyristor emitter, said first MOS transistor integrated in at least one of the semiconductor regions of said thyristor; and

a second MOS transistor integrated in at least one of said semiconductor regions connected between said cathode terminal and said thyristor gate, a gate terminal of said second MOS transistor connected to said cathode terminal,

wherein a first voltage applied to a gate terminal of said first MOS transistor causes a forward current to flow between said cathode terminal and said anode terminal turning said emitter controlled thyristor device to an on state, and a zero to second voltage turns applied to said gate of said first MOS transistor turns said emitter controlled thyristor device to an off state.

2. An emitter controlled thyristor device as recited in claim 1 further comprises a floating ohmic contact (FOC) for shorting said emitter and a source terminal of said first MOS transistor.

3. An emitter controlled thyristor device as recited in claim 1 further comprises a metal strap for shorting said thyristor emitter and a source terminal of said first MOS transistor.

4. An emitter controlled thyristor device as recited in claim 1, further

comprising:

a third MOS transistor having a source and a drain connected between said thyristor emitter and a thyristor lower base region, and a gate connected to said cathode terminal.

5. An emitter controlled thyristor device as recited in claim 1 wherein said first MOS transistor comprises a PMOS transistor, and said second MOS transistor comprises a PMOS transistor.

6. An emitter controlled thyristor device as recited in claim 4 wherein said first MOS transistor comprises a PMOS transistor, said second MOS transistor comprises a PMOS transistor, and said third MOS transistor comprises an NMOS transistor.

7. An emitter controlled thyristor device as recited in claim 4 wherein said first MOS transistor comprises a NMOS transistor, said second MOS transistor comprises a PMOS transistor, and said third MOS transistor comprises an NMOS transistor.

8. An emitter controlled thyristor device as recited in claim 4 further comprising a metal strap for shorting said thyristor emitter with one of a drain and source terminal of said first MOS transistor.

9. An emitter controlled thyristor device as recited in claim 1, further comprising a diode connected between said gate of said first MOS transistor and said thyristor emitter.

10. An emitter turn-off thyristor (ETO) device for carrying current between a cathode terminal and an anode terminal, comprising:

a thyristor having a thyristor emitter, a thyristor collector connected to said anode terminal, and a thyristor gate; and

a packaged metal oxide semiconductor (MOS) transistor connected between said thyristor emitter and said cathode terminal, wherein said thyristor is turned on to conduct current between said cathode and said anode terminal by applying a first voltage to a gate of said MOS transistor and turned off by applying a second voltage to said gate of said MOS transistor.

11. An emitter turn-off thyristor (ETO) device as recited in claim 10 further comprising:

a diode connected between said thyristor gate and said cathode terminal, wherein a threshold voltage of the diode is higher than a voltage drop across the thyristor gate to cathode plus a voltage drop across said MOS transistor in an on-state.

12. An emitter turn-off thyristor (ETO) device as recited in claim 11, further comprising:

a charge storage device connected in parallel with said diode, said charge storage device providing a turn-on current for said thyristor gate.

13. An emitter turn-off thyristor (ETO) device as recited in claim 12 wherein said diode comprises at least one Zener diode.

14. An emitter turn-off thyristor (ETO) device for carrying current between a cathode terminal and an anode terminal, comprising:

a thyristor having a thyristor emitter, a thyristor collector connected to said anode terminal, and a thyristor gate;

Figs. 13A, 13B

a first metal oxide semiconductor (MOS) transistor connected between said thyristor emitter and said cathode terminal;

a charge storage device connected between said thyristor gate and said cathode terminal; and

a second MOS transistor connected in parallel with said charge storage device, wherein said thyristor is turned on to conduct current

between said cathode and said anode terminal by applying a first voltage to a gate of said first MOS transistor and turned of by applying a second voltage to said gate of said first MOS transistor.

15. An emitter turn-off thyristor (ETO) device as recited in claim 14 wherein said second MOS transistor is a PMOS transistor having its gate terminal and drain terminal connected together to said cathode terminal.

16. An emitter turn-off thyristor (ETO) device as recited in claim 14 wherein said second MOS transistor is a NMOS transistor having its gate terminal and source terminal connected together.

17. An emitter turn-off thyristor (ETO) device package comprising:

a first die comprising a gate-turn off thyristor (GTO), said first die having an anode terminal, a thyristor gate, and at least one emitter finger; and

at least one second die comprising a metal oxide semiconductor (MOS) transistor connected in series with said first die, a first terminal of said MOS transistor contacting at least one said emitter finger, and a second terminal of said MOS transistor acting as a cathode terminal,

wherein a first voltage to a gate of said MOS transistor turns said thyristor on passing current between said cathode terminal and said anode terminal, and a second voltage to a gate of said MOS transistor turns said thyristor off.

18. An emitter turn-off thyristor (ETO) device package as recited in claim 17, further comprising:

a plurality of said emitter fingers on a surface of said first die;

a plurality of said second die, each comprising a MOS transistor connected in series with said first die on one of said plurality of emitter fingers; and

fig. 15A, 15B

a metal strip sandwiched between each of said plurality of emitter fingers and each of said plurality of second die.

19. An gate turn-off (GTO) thyristor device package comprising:

a first metal plate;

a second metal plate;

a third metal plate electrically insulated from said second metal layer;

a thyristor sandwiched between said first metal plate and said second metal plate, a collector of said thyristor contacting said first metal plate acting as an anode for [said ETO device package];

a first metal oxide semiconductor (MOS) transistor positioned on said second metal plate adjacent said thyristor, said first MOS transistor having a first terminal connected to an emitter of said thyristor and [a second terminal connected to said third metal plate] acting as a cathode for [said ETO device package]; and

a second MOS transistor positioned on said second metal plate adjacent said thyristor, said second MOS transistor having a first terminal connected to a gate of said thyristor, said second MOS transistor further having [a second terminal and a gate terminal connected to said third metal plate],

wherein a first voltage applied to a gate terminal of said first MOS transistor turns said thyristor to an on state causing a current to flow between said cathode and said anode, and a zero to second voltage applied to said gate of said first MOS transistor turns said emitter controlled thyristor device to an off state.

20. An gate turn-off (GTO) thyristor device package as recited in claim 19, further comprising a clamp means for holding said first, second and third metal layers together.

21. An gate turn-off (GTO) thyristor device package as recited in claim 19

wherein said first, second, and third metal plates comprise copper plates.

22. An gate turn-off (GTO) thyristor device package as recited in claim 19 wherein said first MOS transistor and said second MOS transistor are complementary.

23. An gate turn-off thyristor (GTO) device package comprising:

a gate turn-off (GTO) thyristor comprising a thyristor gate, a thyristor emitter, and a thyristor collector forming an anode terminal;

a plurality of MOS transistors connected in parallel arranged in a circular fashion around said GTO thyristor, a first terminal of said MOS transistors connected to said thyristor emitter and a second terminal of said MOS transistors connected to a cathode terminal of said GTO device package; and

a plurality of MOS switching devices connected in parallel arranged in a circular fashion around said GTO thyristor, a first terminal of said MOS switching devices connected to said thyristor gate and a second terminal of said MOS switching devices connected to said cathode terminal of said GTO device package,

wherein a first voltage applied to a gate terminal of said MOS transistors turns said GTO thyristor to an on state causing a current to flow between said cathode terminal and said anode terminal, and a zero to second voltage applied to said gate of said MOS transistors turns said GTO thyristor to an off state.

24. An gate turn-off thyristor (GTO) device package as recited in claim 23 further comprising:

a first metal plate forming said cathode terminal;

a second metal plate separated from said first metal plate by an insulation layer, wherein said GTO thyristor and said MOS transistors and said MOS switching devices are positioned on said second metal plate, said

first and second metal plates acting a heat sink.

25. An gate turn-off thyristor (GTO) device package as recited in claim 23 further comprising a third metal plate on top of said GTO thyristor forming said anode terminal.

26. An gate turn-off thyristor (GTO) device package as recited in claim 23 wherein said MOS switching devices comprise a MOSFET transistor having a gate connected to said cathode terminal.

27. An gate turn-off thyristor (GTO) device package as recited in claim 23 wherein said MOS switching devices comprise a diode.

28. An gate turn-off thyristor (GTO) device package as recited in claim 23 wherein said MOS switching devices comprise a diode connected in parallel with a capacitor.

29. An gate turn-off thyristor (GTO) device package as recited in claim 23 wherein said MOS switching devices comprise a Zener diode connected in parallel with a capacitor.

30. An gate turn-off thyristor (GTO) device package as recited in claim 23 wherein said MOS switching devices comprise a transistor connected in parallel with a capacitor.

31. An gate turn-off thyristor (GTO) device package as recited in claim 26 further comprising;

[a first feedback path connecting said gate terminal of said MOS transistors to said thyristor emitter; and

a second feedback path connecting said gate terminal of said MOS transistors to said thyristor gate terminal through a diode.

32. A gate turn-off thyristor (GTO) device package as recited in claim 23 further wherein [said MOS switching device] comprises a MOS transistor comprising;

a feedback path connecting said gate terminal of said MOS transistors to said thyristor emitter;

a capacitor connected in parallel to [said second feedback path] connecting said gate terminal of said MOS transistors to said thyristor gate terminal through a diode.